C L A I M S

1. A process for controlling the performance of a homogeneous charge compression (HCCI) engine in a vehicle having a hydrocarbon fuel reservoir which process comprises adjusting the octane or cetane number of hydrocarbon fuel being supplied to the HCCI engine by:

(a) converting a portion of hydrocarbon fuel from the hydrocarbon fuel reservoir to synthesis gas;

(b) converting synthesis gas produced in step (a) to a mixture of hydrocarbons having an octane number less than or a cetane number higher than that of the hydrocarbon fuel of the hydrocarbon fuel reservoir using a Fischer Tropsch process;

(c) delivering (i) a portion of hydrocarbon fuel from the hydrocarbon fuel reservoir and (ii) a portion of the mixture of hydrocarbons produced in step (b) to the HCCI engine; and

(d) varying the amounts of (i) and (ii) in step (c) in order to adjust the octane or cetane number of the hydrocarbon fuel being supplied to the HCCI engine.

2. A process according to claim 1 or claim 2 wherein at least part of the water required for step (a) is obtained by condensing an exhaust gas stream from the engine or vehicle.

3. A process according to any one of the preceding claims wherein the synthesis gas used in step (b) has a hydrogen gas to carbon monoxide ratio in the range of 0.6 to 2.5 part hydrogen gas for every part carbon monoxide.

4. A process according to any one of the preceding claims wherein heat of reaction from the Fischer Tropsch process of step (b) is used to:

(i) provide heat for the reaction of step (a) of claim 1; and/or

(ii) preheat the reactants for the reaction of step (a) of claim 1.

5. A process according to any one of the preceding claims wherein the Fischer Tropsch process in step (b) is followed by a condensing step which produces a light and a heavy fraction and wherein the light and/or the heavy fraction form at least part of the mixture of hydrocarbons in (ii) of step (c) of claim 1.

6. A process according to claim 5 wherein the condensing step produces a light fraction and a heavy fraction and at least a part of the light fraction is either

(a) stored in a pressurised storage container;

(b) delivered to the HCCI engine; or

(c) recycled by converting it to synthesis gas in step (a) of claim 1.

7. A process according to claim 5 or claim 6 wherein cooling water for the condensing step is provided by a cooling system for the HCCI engine or vehicle.

8. A process according to any one of the preceding claims which process further comprises monitoring the performance of the HCCI engine using a sensor to provide information relating to engine performance and adjusting the octane number or cetane number in response to said information.

9. A process according to claim 8 wherein the sensor is a knock sensor.

10. A process according to claim 8 or claim 9 wherein an engine management chip receives information from the sensor and processes said information to provide data from which the required amounts of (i) and (ii) of step (c) in the process of claim 1 can be determined.

11. A HCCI engine and fuel system comprising

(a) a fuel reservoir;

(b) a HCCI engine;

(c) a reformer for converting hydrocarbon fuel to synthesis gas;

(d) a reactor for converting synthesis gas to a hydrocarbon mixture using a Fischer Tropsch process;

(e) means for removing a portion of hydrocarbon fuel from the fuel reservoir and delivering it to the reformer;

(f) means for removing synthesis gas product from the reformer and delivering it to the reactor;

(g) means for removing a mixture of hydrocarbons from the Fischer Tropsch reactor and delivering it to the HCCI engine; and

(h) means for removing a portion of hydrocarbon fuel from the fuel reservoir and delivering it to the HCCI engine.

12. A HCCI engine and fuel system according to claim 11 which further comprises a condenser for converting a hydrocarbon mixture produced by the reactor into a light and a heavy fraction; and the means specified in (g) includes means for removing a portion of the heavy fraction and/or the light fraction produced by the condenser and delivering it to the HCCI engine.

13. A HCCI engine and fuel system according to claim 11 or claim 12 comprising a sensor for monitoring the engine's performance.

14. A HCCI engine and fuel system according to claim 13 comprising an engine management chip.

15. A HCCI engine and fuel system according to any one of claims 11 to 14 which further comprises one or more of:

(a) a pressurised storage container for storing the light fraction produced by the condenser;

(b) a trap for removing sulphur from the synthesis gas being fed into the Fischer Tropsch reactor; and

(c) a hydrogen removal unit for removing hydrogen from the synthesis gas product from the reformer before the synthesis gas is fed to the Fischer Tropsch reactor.

16. A vehicle comprising the HCCI and fuel system of claims 10 to 15.